Project Title: "MTBE Diving Plumes" Task 10641

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Collaborators: U.S. EPA Region 5, Illinois Environmental Protection Agency, Wisconsin Department of Natural Resources, Michigan Department of Environmental Quality, New York Department of Environmental Conservation.

Introduction to the problem. There are approximately 400,000 confirmed releases of gasoline from underground storage tanks in the United States. At least 200,000 contain MTBE at significant concentrations. The ground water impacts from these releases are monitored with shallow wells surrounding the releases. Because there are so many spills, and because monitoring wells are expensive, there is a strong economic incentive to keep the network of monitoring wells simple and small. Occasionally MTBE plumes will move below the bottom of the screen of conventional monitor wells and escape detection. This is called plume diving. If the MTBE plume escapes detection it can contaminate public water supply wells.

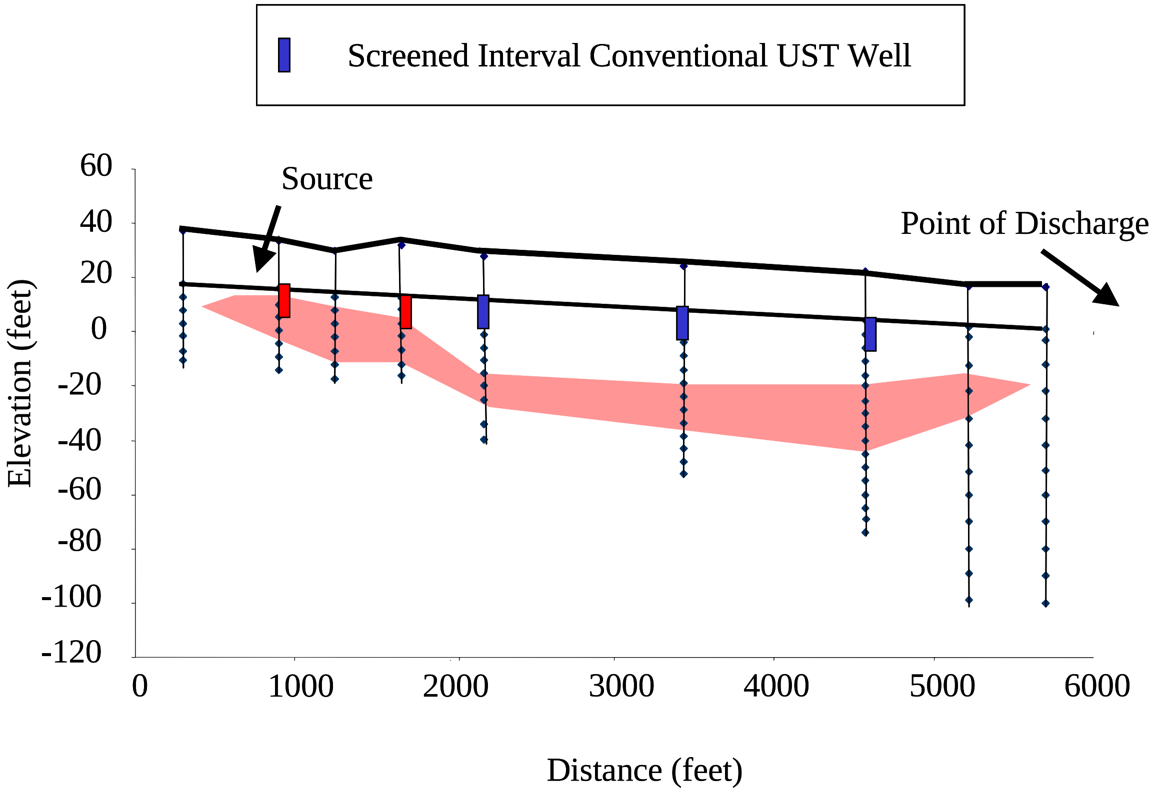
Background: Because MTBE does not sorb to aquifer material, and because there is no biological degradation in many plumes, there is an opportunity for MTBE plumes to be very long. The longer the plume, the more likely that it will dive below the screen of conventional monitoring wells. Plumes can dive deeper into aquifer by a number of mechanisms. Plumes can be buried by recharge of precipitation moving down to the aquifer from the surface. Plumes tend to flow around clay layers and through sand or gravel layers. If the layers that control flow of ground water dive into the aquifer, so will the plume.

Objectives: 1) Document the phenomenon of plume diving at real gasoline spills, 2) Determine the properties of the aquifer that caused the plume diving, 3) Develop or evaluate tools that can be used to predict plume diving, and identify the best depth intervals for monitoring wells to detect diving plumes. 4) Develop criteria that can be used to recognize MTBE plumes with no natural biodegradation.

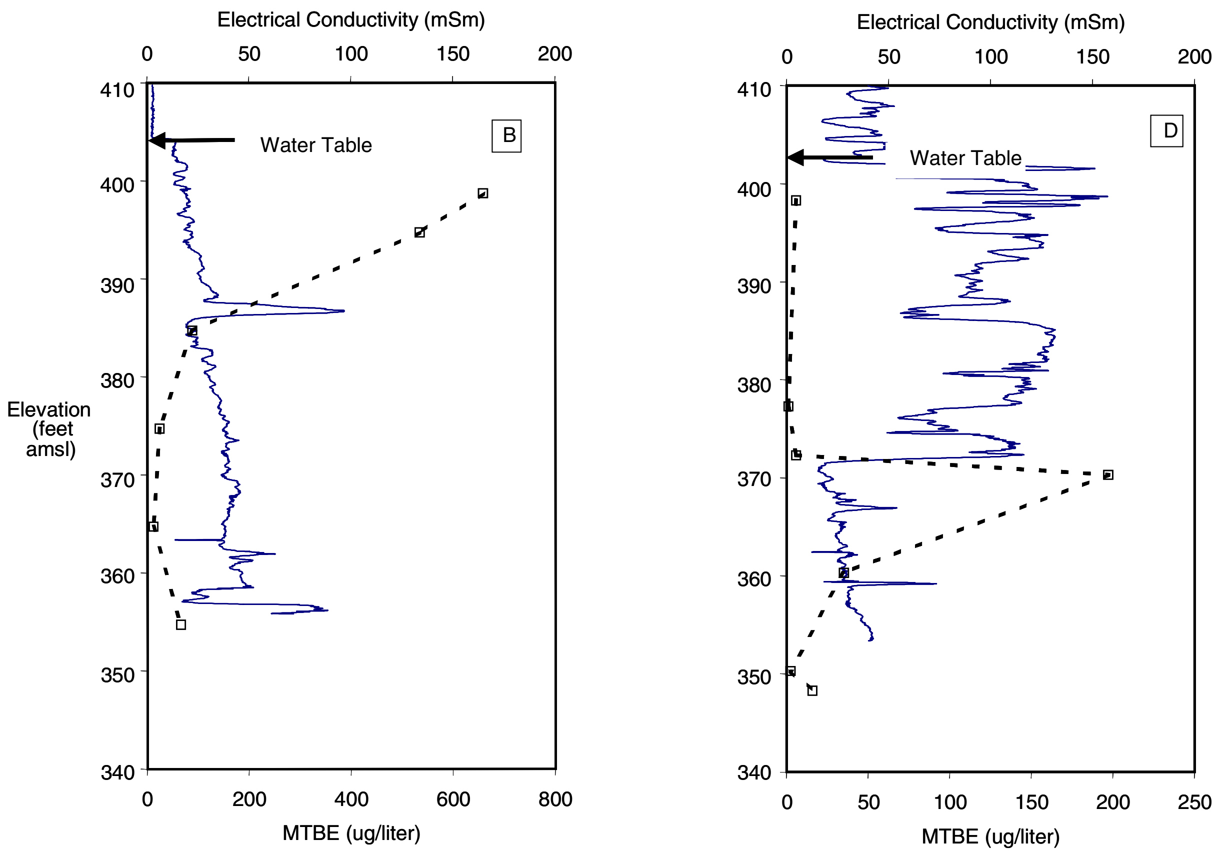
Approach: Detailed case studies were conducted on MTBE plumes at East Alton, Illinois, Spring Green Wisconsin, and Milford Michigan. Each of these plumes impacted a municipal water supply well. Plume diving through burial by recharge was estimated using an EPA application available on the web. Plume diving caused by structure of the aquifer was estimated by determining the vertical distribution of clay and sand layers, and the vertical distribution of hydraulic conductivity. The geochemistry of the receiving groundwater, and of the plume was characterized to recognize conditions where MTBE did not degrade.

Accomplishments to date (24 Feb 2003): At all three sites, the MTBE plumes dived deeply into the aquifer. Diving of the plume at Spring Green, Wisconsin could be predicted from aquifer recharge using the plume diving calculator (link to http://www.epa.gov/extrmurl/learn2model/part-two/onsite/diving.htm). Plumes at the East Alton Illinois site and the Milford Michigan site followed layers of sand and were constrained by layers of clay in the aquifer. The plume was found at the contact between a deep layer of sand and the layer of clay above it. Clay and silt often have high electrical conductivity and sand and gravel often have low conductivity. A simple tool recently available on the market can determine the electrical conductivity of aquifer material to depths of 100 feet or greater at reasonable cost. The tool was used at the East Alton site to map the clay and sand layers and predict the most likely interval to harbor the plume. Water samples were collect in discrete vertical intervals. The highest concentrations of MTBE were in the intervals that were predicted from the electrical conductivity measurements. In most aquifers, bacteria will degrade MTBE readily if oxygen is available. At all three sites, the MTBE plume was devoid of oxygen. At the East Alton Illinois site, the uncontaminated water in the aquifer was also devoid of oxygen.

Near future tasks: A journal article has been submitted for publication in *Ground Water Monitoring and Remediation* titled: "Site Characterization to Determine the Influence of Stratigraphy on a Diving Plume of MTBE in a Municipal Well Field" by John T. Wilson, Randall R. Ross, and Steven Acree. An EPA report on Plume Diving is in preparation.



Conventional Wells That Are Screened over the First Ten Feet of the Aquifer Cannot Detect the Downgradient Portion of a Plume of MTBE at the Hagerman Avenue Site on Long Island, NY.



Association of higher concentrations of MTBE with sandy aquifer material (low electrical conductivity) along an inferred ground water flow path from the potential sources of the MTBE (location B), to a location where the plume dived deep below the water table (location D). Electrical Conductivity logs are the solid lines, concentrations of MTBE are the dashed lines.